WHAT IS THE CONSENSUS OF OPINION AS TO THE PLACE OF SCIENCE IN THE PREPARATORY SCHOOLS?

THE first professor of physics and chemistry in the United States took his chair in the College of William and Mary in 1774. About seventy-five years later, scientific schools were started at Harvard and Yale, and the Smithsonian Institute opened its doors. It was not till 1865 that the first physical laboratory for the use of students in the United States was opened by Professor E. C. Pickering at the Massachusetts Institute of Technology. Scientific science teaching, that is by the laboratory method, has, therefore, been developed within a period of a little more than thirty years; and the greater part of the growth has taken place during the past ten years. As an instance of the rapidity of this growth your attention is called to the fact that of the twenty-one representative colleges and universities reported upon by the United States Commissioner of Education in his annual report of 1886, seven, or just one-third had science requirements for admission. By reference to the report of the committee on college entrance requirement in the SCHOOL REVIEW of June, 1896, you will find that fourteen, or just two-thirds, of the same twenty-one institutions have science requirements for admission. Nor is that all; a comparison of the two tables shows a substantial gain both in quantity and quality of such requirements. When you compare the present condition of science, both in the secondary schools and in the higher institutions, with that of a few years ago, the development seems little short of marvelous. But the change has not taken place without a contest. The war has been, for the most part, between Latin and Greek on one side and the physical sciences on the other. The third member of the ancient triumvirate, mathematics, has caused little contention. Indeed the

tendency has been to increase the amount required without serious protest from either side. English, history and the modern languages have also come in for a share of the discussion; but the real tug of war has been, and is, between the classics and the sciences.

The contentions of the classical advocates were these:

1. The classical programme embodies the best thought of the best minds, and it has to show as its products the majority of the master minds of the past four centuries. It has stood the test of time, and is entitled to the consideration that attaches to an established position.

2. In spite of the fulminations of the scientist, practically all of the colleges still require the classics for admission, and this is a strong presumption in their favor.

3. The mastery of the traditional subjects renders the mastery of other subjects relatively an easy task.

4. Experience has proved that when different courses in secondary schools are offered, the superior students almost invariably choose the classical course.

5. The classics, as a means of securing that general training which prepares the youth for meeting successfully whatever emergencies may arise in life, have no rivals.

6. The proper effect on the minds of the pupils cannot be produced without prolonged study, and anything less than the time now given them in the preparatory schools is inadequate.

7. The superiority of the classics over living languages which the scientists would substitute for them, lies in this: a living language does not so readily lend itself to purposes of dissection and grammatical formulation as does one that is no longer subject to evolution, hence the study of the classics can be made more scientific than the study of modern languages. Besides the ease of acquisition of the modern languages impairs their efficiency as disciplinary studies.

8. The intrinsic merits of the literature of the classics are such that there comes from their study a mastery of style, an elegance of diction, not to be secured in any other way. More-

over, the arts and letters of the civilized world are Greek, as its laws and history are Roman; and to study a subject scientifically you must study its embryology.

9. The introduction of the sciences in the programmes means a loss to the system without any assurance that the new subjects will make good the loss.

10. It is essential to any proper mental training that a lad should master not only what he likes, but what he does not like. Science studies, because of their showy character, are attractive to the immature; so pupils, if given their choice, will take the sciences and drop the more difficult culture studies.

11. Too much science study tends to lower our ideals, and will cause us to degenerate into a mere money-getting and pleasure-getting people.

12. The constant use of the more rigorous and exact methods of science tends to unfit men for dealing with human questions which are more inexact in their nature.

13. The student of science is always exercising his intelligence on a limited part of human experience, while the student of language in the extended sense may be said to be always in contact with the whole. The humanities, alone, truly educate a human being.

On the other hand, the scientists argue:

1. The sciences are a most valuable aid to work in language, since the written results of every experiment is an exercise in English.

2. Science study, more than any other, gives discipline of the powers of observation, of logical thought, and accurate description.

3. The classical students are broadened by contact with science study, just as the scientific men are more liberal for having studied the humanities.

4. Among studies of equal disciplinary value the true criterion is the use that may be made of the subject in future work.

5. The influence of the study of science on modern thought is shown by the terms "laboratory method" and "scientific

method" as applied to economics, history, and even language and literature.

6. The marvelous industrial progress of Germany, as compared with that of other European countries, is due to the superior skill and wisdom of her men of science; and every student when he enters the university has had nine years training in science work.

7. The study of the sciences, especially of the experimental sciences, induces a love for experimentation, investigation and discovery.

8. The ignorance of natural laws is the basis of all degrading superstitions. The study of science more than that of anything else demonstrates in an intelligible way the reign of law in the universe.

9 Each age brings new demands. The scholastics have had their day. It is supreme folly to ignore science the applications of which are such an important factor in our life of today. Through the study of science every child is better fitted to cope with his environment. Strict humanism means education today in what was the best thought of the human race five hundred years ago. It ignores the grand achievements of the age. The old is out of harmony with the times. It is narrow and not liberal as it professes to be.

10. The utility of all science and of all knowledge consists in an ability by the aid of it to foretell the future. It is the study of science that most surely enables one to predict. The exactness of the science of astronomy is a case in point.

11. Nothing but stern objective realities can constitute a safe foundation for any future moral or social system. It is the special merit of science that it tends to bring the world back to nature from which it has so far wandered.

12. The claim of the classical advocate that energy created by activity flowing in one channel may be turned at will into any other channel is only a partial truth. If an effort is made to turn it into a widely different channel much is lost by leakage; just as in coverting energy of chemical union into the

energy of the electric current a very large percentage is lost in the act of transformation. Hence the needs of the times demand a wider range of subjects than is offered by the classical programme.

13. The contention of the classicists that their plan is complete for all time, that they have staked off the bounds of human endeavor as regards the necessities of the growing mind, is practically a declaration that the process of evolution is suspended.

At the beginning of the controversy the scientists held that a certain kind and amount of science was a proper preparation for higher education. Their opponents denied it; but in time they came to admit that for pupils who were not going to college science might properly form a part of the curriculum. Then the scientist argued that a considerable number of pupils who elect the general course, decide late in the course that they desire to go to college; and it is unwise to cut them off from the higher intellectual life on account of a failure to forsee their necessities. Their opponents no sooner showed a disposition to weaken on this point than the scientists came out strongly in behalf of the proposition that what prepares a young person for his life work ought also to prepare him for college. From this it was but a step to the doctrine of the equivalence of studies having the same time allotment.

The truth is, there is almost an infinity of good things that can be said in favor of almost any rational subject of study, if presented under ideal conditions. But ideal conditions do not obtain. Hence it is always possible, if a speaker or writer is so disposed, to paint the results of any subject, as it is actually taught, in sombre colors; and the weakest of all argument, ridicule, is not infrequently employed. It thus comes about that there is much rhapsodizing as well as much unfair criticism on both sides. It very soon becomes apparent to a reader of the mass of literature published during the past ten years on the respective merits of the classics and the sciences that much of the argument is fundamentally weak. The con-

test at times loses its legitimate dramatic character and takes on the features of an extravaganza. Quotations from two very recent papers will serve to illustrate: "Any one, I care not who, can and will derive vastly more good from one year of any natural science than from two years of either Greek or Latin;" and this from another source, "When the machine shops and factories and all the paraphernalia of the applied sciences are imported into the academic shades, and when the perfume of the Attic violet is stifled by the stenches of the chemist's crucible, the true purpose of the university is forgotten, and its higher mission is in a great measure sacrificed."

"What is the present consensus of opinion as to the place of science in the preparatory school?" The first man, an eminent scientist, to whom I put this question assured me that the answer, if printed, would read as follows: The preparatory school should give one year of experimental physics, one year of biology, and one year of physiography and physiology. The next answer received—this, too, from an eminent specialist—was this: The consensus of opinion is that there is no consensus; the dispute among the scientists themselves is acrimonious, while the conflict between the friends of the sciences and the votaries of the classics is well-nigh irrepressible. A little later, Professor Davis of Harvard wrote me: "There is no real consensus, unless to the effect that something must be done for science; but there is no close agreement as to what it shall be." The same mail brought this from Professor Butler of Columbia: "In my judgment there is nothing like a consensus of opinion among preparatory schoolmen as to the place of science, or anything else." My first interview inspired me with hope; the second gave birth to a doubt; and subsequent testimony, of which I have accumulated much, makes it clear that the question is too much involved to admit of a specific answer at present. There is no oneness of opinion, in the broad sense; the conflicting interests are manifold. Yet there is, probably, after all, a unity in the midst of diversity if it could only be found. The most that can be hoped for now is an approxima-

tion which, on the main question, can be little more than a plurality vote; on certain specific questions, however, the approximation may rise to the dignity of a majority vote.

Since the report of the Committee of Ten was issued four years ago, many secondary school programmes have been reconstructed or greatly modified. The most of the changes have been in line with the recommendations of the committee. The joint conference on scientific subjects held at Chicago passed a resolution to the effect that one-fourth of the entire high-school course ought to be devoted to the natural sciences; and the Committee of Ten declared this recommendation to be a moderate one.

During the months of September and October, I sent out to all parts of the country about 300 circulars asking for various items of information as to the place of science in the preparatory schools. About 200 replies were received. Of these about one-third came from college presidents and professors, very nearly another one-third came from principals of high and preparatory schools, and the remainder came from teachers in secondary schools.

One of the questions was: What is the "due share" of science? Is one-fourth of the entire time too much or too little? Almost 64 per cent. of those who replied favored one-fourth, while 11 per cent. thought one-third not too much. The remaining 25 per cent. were of the opinion that one-fourth is more than justice demands. A few of this last-named class thought one-twelfth of the time enough for science, but the most of them favored one-fifth. Those who placed the share as low as one-twelfth were, in every case, men connected with private preparatory schools. Thus it would appear that three-fourths of those interested in the subject are favorable to the giving of not less than one-fourth of the entire time to science. Yet a study of the recently reconstructed programmes shows that practice here, as in other directions, is scarcely on speaking terms with precept. I have yet to see a high-school programme, and I have quite a collection, which gives one-fourth or even

one-fifth of the entire time to science. A number of programmes have a system of electives so arranged that the pupil may, if he so desires, give one-fourth, or even more than one-fourth, of his entire time to science. The general course in the New York high schools is a case in point. Thus it would seem that it is pretty generally agreed that science should have a larger place in the curriculum than it has hitherto had assigned to it, but that larger place is not necessarily a required one. Various reasons may be given for this state of affairs, but the one having greatest weight is probably this: the most of the colleges as yet refuse to accept for admission any considerable share of science work.

"Should all real science work count toward admission to college?" This question came nearer bringing out a consensus of opinion than any other one asked in the circular. Almost exactly 90 per cent. answered "yes;" but a great many added "if it is *real* science work." Quite a number specified that it should not be made up of scraps, and that it should be laboratory science work.

The question "What is the minimum of time that should be given any science taught in a preparatory school?" brought out the facts that 66 per cent. favored five periods each week for not less than one year, and that 10 per cent. favored more than that amount. So the approximate consensus is that any science properly taught for one full year by the laboratory method should count toward admission to college. This is the actual requirement for entrance credit at Leland Stanford. The sentiment of President Eliot on this question, "It would be a pity if we could not adapt our courses in college to any good teaching in the schools," I find so frequently quoted with approval that it seems reasonably safe to conclude that the day is not far distant when the college will make it possible for the secondary schools to follow their own inclinations in teaching without the fear that their graduates may fail to enter college. Harvard with her new definitions, including six new options in science, has made a long step in the right direction.

The replies to the question, "Is there a distinct tendency to lessen the number of subjects in science and to devote more time to each one taught?" make it appear that the movement toward making science work more intensive and less extensive meets with greater favor in the West than in the East or South. Seventy per cent. of those who replied think there is such a tendency; but more than five-sevenths of them live west of Ohio and north of Mason and Dixon's line, while of the 13 per cent. who answered in the negative just three dwell within those limits. So the consensus on this point seems to have a distinct sectional bias.

The replies to the question, "Should a year of science offset a year of Latin or Greek as a college entrance requirement?" were peculiar because of their tartness in a great many cases. The other queries only bore incidentally on the question of the classics *vs.* the sciences. But this one touched many in a sensitive spot. "No, never," and "yes, always," both strongly underscored, were the favorite answers. Almost 70 per cent. favored the offset and 26 per cent. opposed it. The rest of the answers were more or less equivocal. Some favored the offset for Greek, but not for Latin; others answered "yes, under certain conditions; and still others thought that it should not at present, but might when the sciences are as well taught as the classics.

The sixth and last question was, "Which is preferable: (*a*) to divide the time alloted about equally among four branches of science, or (*b*) to give the pupil his choice between the above plan and one in which he gives two years each to any two of the four subjects offered, or (*c*) to devote four years to a thorough study of one subject, supplementing it with reading and discussion of the other branches?"

In making a choice from these three plans, the correspondent need not, of course, necessarily indorse any one as the ideal plan. The three are radically different, and my purpose in asking for judgment on them was to ascertain the trend of sentiment rather than to get an indorsement of any specific programme. The third plan is a radical one, and I did not expect

to find many favorably disposed toward it. Of the nearly two hundred answers received, 43 per cent. favored the first, 42 per cent. the second, and 15 per cent. the third. Those who declared in favor of the first plan may be properly divided into two classes: First, those who really favor giving a year to each of four sciences; second, those who chose that plan because it was the least objectionable of the three. But, of course, the same reasoning could not apply to those who selected plan two or three. Of those who chose plan three almost one-half were college men. But since there were just about twice as many replies received from secondary school men as from college men, it is evident that the sentiment in favor of specializing in the science is somewhat stronger among the latter. Now, if you consider the present state of science in the secondary schools, that the great majority of the schools give only from one-third to one-half a year to each science taught, that comparatively few give as much as one year each to two different sciences, and that almost none give so much as one year and a half to any one science, you must admit that the percentages of answers just given show a condition of mind that is decidedly favorable to the immediate future of science in the secondary school. It indicates, so far as a mere "counting of noses" can indicate anything, that there is a decided growth of sentiment in favor of devoting not less than two years to the study of some one or two sciences. Furthermore, it seems to point to the fact that the one-time hobgoblin, "specialization in science in the secondary schools," which has terrorized the timid and frightened even the bold, is losing something of its supreme awfulness. I am aware that some theoretical as well as practical arguments can be arrayed against it. Among the more potent ones are these: First, it narrows at a period of the pupil's life when a special effort should be made to broaden; second, the pupil is too immature at the high-school age to profit largely by specialization. Now I find that the most vigorous protests against this alleged narrowing process come from those who most strongly advocate a strict adherence to the traditional lines of prepara-

tion for college. That is to say, four years of Latin or mathematics broadens, but two years of physics or chemistry narrows. I have not a word to say against four years of Latin; but it seems to me that something may be said in favor of two years of chemistry. One year well spent gives the pupil a fair start in any science. At the end of a year he has learned the terminology; he has acquired a certain degree of skill in the manipulation of the special apparatus; he knows enough of the elements of that particular branch to give him a glimpse of its possibilities, and his interest is aroused. That is, he has lifted the latch and the door is ajar, but not yet open. At this point he is required to drop the subject, only to begin another which has a different terminology, requires different apparatus and a different general treatment. True, he is still to use the scientific method; but the new work is not more difficult than that which he did a year before, it is only different in kind. The direct line of thought and action must be broken, and this, it seems to me, entails a distinct loss that might be avoided. Any line of reasoning that defends specializing in language, history, or mathematics in the secondary school—and by specializing I mean presenting them for a term of years—will apply with equal force to natural science. I do not maintain that the practice of dropping a science at the end of each term or each year to take up a different one is strictly comparable with that of taking one year of English, then one of Latin, followed by one of Greek and another of French or German, but the two plans have enough in common to condemn both.

But, is it true that the pupil is too immature to make this continuous work in science profitable? An ideal curriculum is one of increasing difficulty from beginning to end. If, then, you can, for example, defend the teaching of physiography in the first year of the high-school course, I do not see how you can consistently oppose continuing the same subject the following year. If the pupil is too immature for the advanced work of the second year, it must be equally true that he was too immature for the first year's work.

It may be objected that the schools have neither the apparatus nor competent teachers for a two years' course. It must be granted that this is true of many schools, but there are many of which it is not true so far as competent teachers are concerned, at any rate. In the school from which I am a delegate there are at least four college graduates — two of them holding the doctor's degree — who would be glad of an opportunity to conduct two-year courses in science. Nor do I think that this school stands alone in this respect. Besides, the way to get a supply of anything is to create a demand. When more teachers capable of doing advanced work are seriously wanted, they will be forthcoming. Moreover, the questions of apparatus or competent teachers are not germane to the subject, for we are discussing the needs of the pupil rather than what is convenient, or immediately expedient.

Let me now call your attention to another phase of the question. Long before the child begins the formal study of number, he begins to apprehend the nature of quantity. The possession of that kind of knowledge is one of the fundamentals. Without it one can do nothing. It is as necessary to the success of the painter or sculptor, or musician as it is to the carpenter, the blacksmith, or the money changer. A very large share of our experiences consists in making measurements, and although we do not always use the micrometers or the surveyor's chain, the fundamental idea that lies at the base of all our calculations and speculations is one and the same. Just to the extent that we are accurate in our measurements, whether applied to things material or immaterial, to that same extent are we successful in attaining that for which we strive. Qualitative relations, too, are necessary, but the final test is quantitative accuracy in the product. Within certain limits, at least, the more accurate it is the greater value it possesses. The testimony of the chemist who proves the presence of arsenic in the body of the supposed victim of poison possesses a certain value, but its value is immensely enhanced, if the chemist is able to prove that the quantity is sufficient to cause death. Spencer

points out the fact that the much admired Discobolus, as it is posed, must fall forward the moment the quoit is delivered. A reasonably accurate mental weighing of the parts of the figure would have spared the blunder, and added much to the effectiveness of the artist's conception. Astronomers before Kepler knew much concerning the positions and motions of the members of the solar system, but it was left to Kepler to demonstrate that certain of those facts could be weighed and balanced, and synthesized into the great "harmonic law." That is, the established quantitative relations, the effect of which is to fill the mind with wonder and put us a step nearer to that grandest of all conceptions, that this is, indeed, a universe under the control of the laws of the Absolute.

The value of right habits in accurate determinations can scarcely be overestimated. This belief found expression in the report of the Committe of Ten in the shape of a recommendation that laboratory work in physics should be largely quantitative. All the more recent text-books and laboratory manuals on chemistry show the same tendency. But much as we believe in the value of quantitative work, a note of warning may not be out of place, for there is something more than a possibility that the process may be carried too far. The principal of one of the largest New England high schools wrote me a short time ago, that no subject in the curriculum was so thoroughly detested as the physics work required for entrance to Harvard, and that there were more failures in that subject than in all the rest put together. He thought that, by reason of the extreme quantitative methods required, all the life and soul had been taken out of what was once a most fascinating study. The all-important question to be asked of a candidate for admission to college should not be: have you read the Anabasis, or mastered Remsen's Briefer Course, but have you arrived at a certain stage in the development of those powers which God has implanted in you? The particular road the student has traveled is of little moment. The important fact to be ascertained is that he has or has not reached a certain point. The multiplication of the

courses of study in the secondary schools; the growing disposition to permit greater freedom of choice in the earlier years of the college course; the more general acceptance of the doctrine of the substantial equivalence of studies having the same time allotment; the constant insistance that the teachers must be better prepared for work in the secondary schools; all these point to the same general conclusion, viz., that the question which should confront the applicant for admission to college is not what have you studied, but how well? This does not mean that the pupil in the preparatory school is to have absolute choice. While I find it difficult to accept, without reservation, the doctrine in the report of the Committee of Fifteen, that any subject worthy of a place in an educational scheme may be placed in one of the five categories defined in that document, I do believe that representative studies from each of those five categories should be found in the required part of every secondary-school programme. The omission of any one of these groups, as Dr. Harris has said, "will distort the pupil's view of the world." But within those groups a wide range of choice should be permitted, so that, the individual needs of the pupils may be subserved. By the way, the courses of study adopted by the New York City high schools are most admirably arranged to meet this very need. All this means, so far as it relates to the subject under discussion, that the secondary schools believe that, good work done by them in science, as well as in other subjects, should be accepted by the colleges as a part of the entrance requirements.

One more point and I am done. No word in the language is more abused than the word culture — unless it is that most inclusive of terms, professor. In the war that has raged for years it is not singular that each of the contending parties should seek to establish its claim to a measure, at least, of the best that resides in the other. The exponents of the scientific method as used in natural science work have made, oftentimes, what seem like most extravagant claims as to the culture value of science. On the other hand the members of the aristocracy of culture

have not considered it beneath their dignity to hold that the scientific method is even more applicable to the classics than to the natural sciences. The one claims a monopoly of the scientific method with all accruing benefits including a large share of culture; the other has appropriated and holds as its own the culture of the world, and has used in acquiring it the true scientific method.

The truth probably is that both are right and both are wrong, as is usually the case in such contests. "There is a cant of science as well as a cant of the classics." When Dr. Worship-the-past is at his best an ideal culture secured by and through the scientific method is the rich and varied product. But when the doctor is at his worst, and this happens no one knows how often, both culture and the scientific method are relegated to the storeroom. When the scientific Dr. Up-to-date is at his best the scientific method in action in a marvel of beauty and precision, and real culture grows apace. But when the doctor is at his worst, and he is in this respect a worthy rival of Dr. Worship-the-past, the voice of nature, the music of the spheres is drowned in the noise of the tom-tom, and the name of culture has become a by-word. That is to say, the factor that must never be left out of account in estimating the culture value of any subject, is the personality of the teacher.

Science teaching to yield a worthy culture must be something more than a series of showy and haphazard experiments; but it is also true that Latin teaching must rise above the mere grinding of paradigms, or mechanical and barbarous translations. President Jordan has said: "As volition passes over into action, so does science into art, knowledge into power, wisdom into virtue." Ideally, yes; practically, sometimes. I do not know; but this I do believe most firmly: whatever your definition of culture, there should be in anything worthy of that name a dynamic element which is best derived from a rigid adherence to methods of verification of results. This begets a firm belief in the validity of the deductions resulting from one's individual experience. The student thereby comes to believe in the reign

of universal law. When he arises to this conception, then, and not till then does he fully realize the necessity of obeying the laws of God and man. There are those and their name is legion, who really think that it doesn't matter very much whether we do right or wrong. They observe that evil sometimes goes unpunished, that the apparently good are not always happy. Such persons lose, or never gain, a proper respect for law either civil or moral. They are non-ethical chiefly because they have never risen to the conception of the universal reign of law. This conception need not, it does not, destroy feeling, it is complementary to it. It is not external to culture, a mere corrective, though it does correct. It is, or ought to be, a part of culture. This completeness of result, many of us believe, can be best secured by giving a fair proportion of time in secondary schools to experimental science.

C. C. WILSON

JERSEY CITY, N. J.

DISCUSSION

PROFESSOR E. G. CONKLIN, University of Pennsylvania: With most of the positions taken by those who have immediately preceded me I entirely agree. There are, however, some propositions with which I would take issue and still others which seem to me to demand even greater emphasis than has been given them.

In his fourth thesis Professor Tarr points out a truth which at this time needs to be presented frequently and earnestly. The colleges with relatively few exceptions do not properly recognize the science work done in the preparatory schools. Even in some of our largest universities there are no entrance requirements in science, and in a great number of higher institutions of learning these requirements are ridiculously small. The present attitude of all such institutions is one of positive discouragement to scientific teaching in the schools. There is, of course, a great deal of so-called science work in the schools which cannot be recognized by the colleges; but anyone who will take the pains to acquaint himself with the science work which is being done by the larger high schools, especially in the East and middle West, will be ready to testify that such work is worthy of being